Package ‘MHTcop’

January 21, 2019

Type Package

Title Tests Controlling the FDR / FWER under Certain Copula Models

Version 0.1.1

Description Implements tests controlling the false discovery rate (FDR) / family-wise error rate (FWER) for some copula models.

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

Imports stats, copula, matrixStats, mvtnorm, stabledist, MCMCpack

Suggests knitr, rmarkdown, pbapply

VignetteBuilder knitr

NeedsCompilation no

Author Jonathan von Schroeder [aut, cre],
Taras Bodnar [aut],
Jens Stange [aut]

Maintainer Jonathan von Schroeder <jvs@uni-bremen.de>

Repository CRAN

Date/Publication 2019-01-21 16:10:03 UTC

R topics documented:

- ac_fdr.test
- bolshev.rec.vec
- fwer.support_test
- fwer.ztest
- sample.discrete
- sample.Z

Index 7
Perform a FDR controlling test on marginal p-values that are distributed according to an Archmidean copula

Description

Performs a test on marginal p-values according to the procedure described in Bodnar, Dickhaus (2014). See the vignette vignette('fdr-test',package='MHTcop') for a detailed explanation of the example.

Usage

\texttt{ac\_fdr\_test(p, cop, m0\_Lower, alpha = 0.05, num\_reps = 1e+05)}

Arguments

\begin{itemize}
  \item \texttt{p} \hspace{1cm} The vector of marginal p-values
  \item \texttt{cop} \hspace{1cm} The dependency model for the p-values (for example \texttt{copula::copClayton})
  \item \texttt{m0\_Lower} \hspace{1cm} A lower bound on the number of true null hypotheses (i.e. \texttt{m0\_Lower} is a reasonable lower bound for the number of true null hypotheses), \(1 \leq m0\_Lower \leq \text{length}(p)\)
  \item \texttt{alpha} \hspace{1cm} The desired FDR level
  \item \texttt{num\_reps} \hspace{1cm} The number of samples to draw for the Monte-Carlo integration (default = 1e5)
\end{itemize}

Value

The adjusted p-values \(p\_adjusted\) such that performing the test by rejecting the \(i\)-th hypothesis if and only if \(p\_adjusted[i] \leq \alpha\) is a test at FDR level \(\alpha\).

References


Examples

\begin{verbatim}
#(Using p-values generated from the model (16))
library(copula)
set.seed(1)
m <- 20
m0 <- 0.8*m
p\_values <- rCopula(m,m0\_Copula\_list(1,1:20))
mu\<-runif(m-m0, min=-1, max=1/2)
p\_values[1,(m0+1):m]<-pnorm(sqrt(m)*mu+qnorm(p\_values[(m0+1):m]),0,1)
ac\_fdr\_test(p\_values,set\_Theta(cop\_Clayton,1),m0,0.05,1e4)$test
\end{verbatim}
**bolshev.rec.vec**

*Distribution function of the order statistics of i.i.d. uniform random variables*

**Description**

*bolshev.rec.vec* is a vectorized and unrolled implementation of the Bolshev recursion described in Shorack, Wellner (1986) which can be utilized to calculate probabilities for order statistics of i.i.d. uniform random variables.

**Usage**

*bolshev.rec.vec(m)*

**Arguments**

- **m**: matrix whose columns are p-values sorted in descending order

**Details**

Denote by $U_1, \cdots, U_n$ n i.i.d. uniform random variables on $[0, 1]$. Denote by $U_{1:n}, \cdots, U_{n:n}$ their order statistics. Then the return value $p$ contains the probabilities

$$p[i,j] = P\left( \bigcap_{k=i}^{n} \{m[n-k+1,j] \leq U_{k:n}\} \right)$$

**Value**

matrix $p$ containing the calculated probabilities

**References**


**Examples**

```r
bolshev.rec.vec(cbind(rev(c(0.7, 0.8, 0.9))))
#result: c(0.016, 0.079, 0.271)
#monte carlo simulation
sim <- function(v) mean(replicate(1e4, all(v <= sort(runif(3)))))
set.seed(0)
c(sim(c(0.7, 0.8, 0.9)), sim(c(0.0, 0.8, 0.9)), sim(c(0, 0.0, 0.9)))
#similar result: c(0.0176, 0.0799, 0.2709)
```
Copula-based multiple support test which controls the FWER

Description

Perform a multiple support test controlling the family-wise error rate (FWER) using the procedure described in Stange, Bodnar, Dickhaus (2015).

Usage

fwer.support_test(sample, theta, alpha = 3, beta = 4,
boot.reps = NULL, sigLevel = 0.05)

Arguments

sample  The observed sample (a matrix whose columns are the observations)
theta  The hypothesized scale \( \theta_j \) taking values in \( \{ \theta_1^*, \cdots, \theta_m^* \} \)
alpha  The first shape parameter of the Beta margins
beta  The second shape parameter of the Beta margins
boot.reps  number of bootstrap repetitions for estimating the parameter \( \eta \) of the Gumbel copula. If this parameter is NULL then \( \eta \) is estimated from Kendalls tau and no bootstrap is performed.
sigLevel  The desired significance level

Details

The test is performed assuming an i.i.d. sample \( X_1, \cdots, X_n \) which has the stochastic representation

\[ X_{i,j} = \theta_j Z_j \]

where \( Z_j \) takes values in \( [0,1] \) and which is distributed according to a Gumbel copula with Beta margins. The test simultaneously tests the hypotheses \( H_{0,j} : \theta_j \leq \theta_j^* \) versus the corresponding alternatives \( H_{1,j} : \theta_j > \theta_j^* \).

For usage examples and figure reproduction see vignette('fwer-support-test',package='MHTcop').

Note: If the copula is only in the domain of attraction of the Gumbel copula (but not a Gumbel copula) then it is necessary to pass the number of bootstrap repetitions boot.reps as an additional parameter since the non-bootstrapped parameter estimate would not be consistent.

Value

list l, where

- l$statistic contains the values of the test statistics,
- l$critvalues are the calibrated critical values,
- l$test contains the test decisions,
- l$etahat is estimated parameter of the Gumbel copula
References


---

**fwer.ztest**

Copula-based multiple z-test which controls the FWER

---

**Description**

Perform a multiple (two-sided) z-test controlling the family-wise error rate (FWER) using the procedure described in Stange, Bodnar, Dickhaus (2015).

**Usage**

fwer.ztest(sample, mu, sigma = NULL, sigLevel = 0.05)

**Arguments**

- `sample`: The observed sample
- `mu`: The mean $\mu^*$
- `sigma`: The estimated covariance matrix (the copula parameter). If it is omitted it will be estimated from an AR(1) model
- `sigLevel`: The desired significance level

**Details**

Let $X_1, \ldots, X_n$ denote an i.i.d. sample with values in $\mathbb{R}^m$. Furthermore let $\mu_j = \mathbb{E}[X_{1,j}]$ be the component-wise expectations. Then the multiple (two-sided) z-test simultaneously tests the hypotheses $H_{0,j}: \mu_j = \mu_j^*$ versus the corresponding alternatives $H_{1,j}: \mu_j \neq \mu_j^*$. For usage examples and figure reproduction see vignette('fwer-ztest',package='MHTcop').

**Value**

list l, where

- `l$statistic` contains the values of the test statistics,
- `l$critvalues` are the calibrated critical values,
- `l$test` contains the test decisions,
- `l$etahat` is estimated parameter of the Gumbel copula

**References**

sample.discrete  
*Generate a sample from a discrete distribution*

**Description**

sample.discrete generates a sample of size n given its density function df.

**Usage**

```r
sample.discrete(df, n)
```

**Arguments**

- `df`: The density function - It is assumed that the support is a subset of the natural numbers.
- `n`: The desired sample size.

---

sample.Z  
*Generate a sample from the inverse Laplace-Stieltjes transform of a copula’s generator*

**Description**

sample.Z generates a sample of size n from the inverse Laplace-Stieltjes transform of the generator of the copula cop. For further details see [https://doi.org/10.1016/j.csda.2008.05.019](https://doi.org/10.1016/j.csda.2008.05.019) (especially table 1).

**Usage**

```r
sample.Z(cop, n)
```

**Arguments**

- `cop`: The copula.
- `n`: The desired sample size.
Index

ac_fdr.test, 2
bolshev.rec.vec, 3
fwer.support_test, 4
fwer.ztest, 5
sample.discrete, 6
sample.Z, 6